

MEMORANDUM

To: EAAC
From: James K. Boyce
Re: Investment in Disadvantaged Communities
Date: December 30, 2009

This memorandum discusses issues related to investment in disadvantaged communities, including localities that are disproportionately impacted by co-pollutants associated with use of fossil fuels.¹

AB 32 provisions

Section 38565 of the California Global Warming Solutions Act of 2006 (AB 32) mandates that CARB should seek to channel investment to the state's most disadvantaged communities:

The state board shall ensure that the greenhouse gas emission reduction rules, regulations, programs, mechanisms, and incentives under its jurisdiction, where applicable and to the extent feasible, direct public and private investment toward the most disadvantaged communities in California and provide an opportunity for small businesses, schools, affordable housing associations, and other community institutions to participate in and benefit from statewide efforts to reduce greenhouse gas emissions.

In addition, section 38570(b) mandates that the California Air Resources Board (CARB) should consider localized impacts of co-pollutants:

Prior to the inclusion of any market-based compliance mechanism in the regulations, to the extent feasible and in furtherance of achieving the statewide greenhouse gas emissions limit, the state board shall to all of the following: (1) Consider the potential for direct, indirect, and cumulative emission impacts from these mechanisms, including localized impacts in communities that are already adversely impacted by air pollution. (2) Design any market-based compliance mechanism to prevent any increase in the emissions of toxic air contaminants or criteria air pollutants.

As documented below, disadvantaged communities often are disproportionately impacted by air pollutants, including co-pollutants generated by the use of fossil fuels. One way to respond to these mandates is to allocate a share of allowance value to such communities for the purpose of environmental improvements.

This use of allowance value primarily involves investment, but it also can be categorized as "compensation" in that a community's eligibility to receive benefits rests on its disadvantaged status including disproportionate pollution exposure. However, this differs

¹ This is a revised and expanded version of the author's memo of the same title dated October 5, 2009.

fundamentally from other types of compensation that rest on claims of losses *relative to the status quo ante* prior to AB 32 implementation. The case for compensation to localities rests instead on disadvantages that antedate AB 32. That is, eligibility for compensation does not require that AB 32 causes an increase in co-pollutants in the localities – an outcome specifically prohibited in section 38570(b), quoted above – but rather that disproportionate impacts *relative to other localities* persist after AB 32 implementation. Again unlike other types of compensation, the aim in this instance is not to “make the recipient whole” but rather to mitigate gaps in environmental and economic well-being in disadvantaged localities relative to statewide norms.

General considerations

Co-pollutants and the co-benefits from their reduction are relevant to the efficiency, environmental, and fairness objectives of AB 32.

Efficiency considerations

The efficiency objective implies that policy should seek to maximize net social benefits from reducing greenhouse gas emissions. These benefits include co-pollutant reductions. To ignore them would be tantamount to leaving health-care dollars lying on the ground.

From a climate-change standpoint, the marginal benefit of carbon reductions is constant across emission sources. But in the presence of co-pollutants – such as particulate matter, NO_x, and air toxics released by the burning of fossil fuels – the marginal benefit can and does vary across emission sources.

As is well-known, variations in marginal abatement costs across pollution sources provide the static-efficiency rationale for using market-based incentives (such as cap-and-trade), as opposed relying exclusively on regulatory standards to achieve pollution-control objectives. The aim is to achieve pollution reductions at least total cost.

Variations in marginal abatement benefits complicate the picture, however. These variations provide a rationale for greater pollution reductions (and higher marginal abatement costs) for some emission sources than for others.

Muller *et al.* (2009) estimate that on average, the co-benefits from co-pollutant reductions due to a nationwide cap on carbon emissions will be on the same order of magnitude as the benefits from carbon emissions reduction itself.² In a study of the co-benefits of carbon emission reductions in the European Union, Berk *et al.* (2006) reach similar conclusions.³

² Nicholas Z. Muller, Britt Groosman and Erin O'Neill-Toy, “The ancillary benefits of greenhouse gas abatement in the United States.” Forthcoming, 2009. See http://college.usc.edu/geography/ESPE/documents/Muller_USC_6_30_09.pdf.

³ M.M. Berk *et al.*, “Sustainable energy: Trade-offs and synergies between energy security, competitiveness, and environment.” Bilthoven: Netherlands Environmental Assessment Agency (MNP), 2006.

A 2009 study by the National Academy of Sciences estimates that the burning of fossil fuels in the United States is responsible for roughly 20,000 premature deaths each year, translating into \$120 billion/year in health damages.⁴ This estimate is based on the effects of criteria air pollutants, and does not include damages from climate change, harm to ecosystems, or other air pollutants such as mercury.

The potential co-benefits from co-pollutant reduction are relevant regardless of the extent to which emissions of these pollutants are limited by other environmental regulations. The estimates by Mueller *et al.* and the National Academy of Sciences are based on co-pollutant levels in the existing regulatory environment. Even if these regulations were calibrated to achieve the “optimum” level of pollution as defined by conventional cost-benefit analysis (equating the marginal benefit of pollution reduction to its marginal cost), the co-benefits to be gained by further reducing co-pollutants would be relevant to carbon policy design on efficiency grounds.⁵

In addition to improvements in the quantity and quality of life, benefits from co-pollutant reductions include health-care cost savings, reductions in days lost from work due to illness and the need to care for ill children and other dependents, and gains in property values.

In economic terms, the co-benefits from co-pollutant reduction add to the benefits from reduced carbon-dioxide emissions. This justifies greater reductions (tighter caps, higher permit prices, and higher marginal abatement costs) than would be warranted in the absence of co-benefits.

If co-pollutant intensity, here defined as the ratio of co-pollutant damages to carbon-dioxide emissions, were a fixed coefficient, there would be no efficiency case for modifying policy design (beyond adjusting the cap) to take co-pollutants into account.

⁴ National Academy of Sciences, Committee on Health, Environmental, and Other External Costs and Benefits of Energy Production and Consumption, National Research Council (2009) *Hidden Costs of Energy: Unpriced Consequences of Energy Production and Use*.

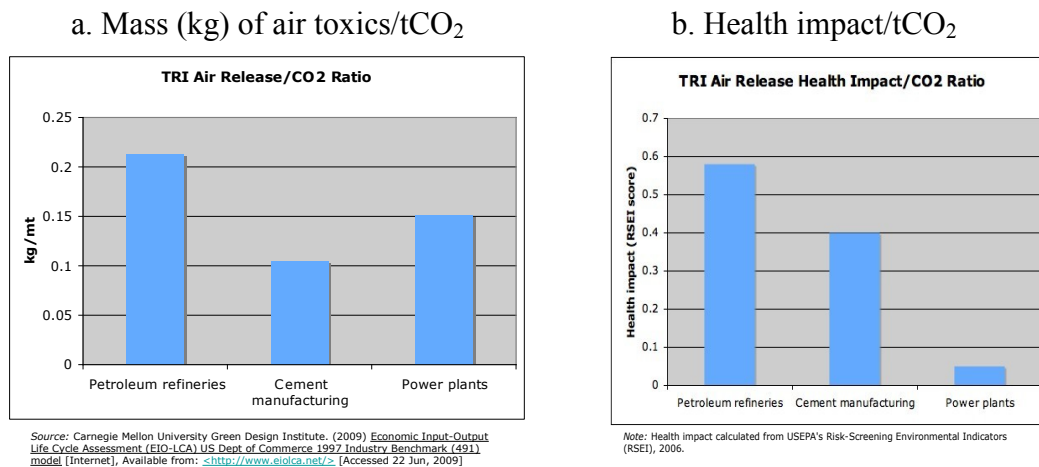
⁵ In a recent paper submitted to the EAAC, written with financial support from the AB 32 Implementation Group and the Western States Petroleum Group, Schatzki and Stavins argue that rather than adjusting greenhouse gas (GHG) policies to account for co-benefits from reduction of co-pollutants, policies for regulation of co-pollutants should be adjusted to account for co-benefits from reduction of GHG emissions. As a rationale they note that co-pollutant impacts are complex, hard to quantify, and geographically variable. But this problem must be faced in formulating *any* policy on co-pollutant regulation, regardless of how interactions with GHG policies are handled. Moreover, as the authors note (p. 13), “most of the measures identified by recent state and regional regulatory plans as effective means of further reducing criteria and toxic pollutants do not involve reducing fuel use,” instead relying on end-of-pipe control technologies. For both reasons, it makes good economic sense to incorporate co-pollutant impacts into carbon policy design. See Todd Schatzki and Robert N. Stavins, “Addressing Environmental Justice Concerns in the Design of California’s Climate Policy” (October 2009), online at http://www.climatechange.ca.gov/eaac/comments/2009-11-03_Schatzki_and_Stavins_attachment.pdf.

But there are strong *a priori* reasons to expect that co-pollutant intensity varies across regions, sectors and polluters. Empirical evidence supports this view.

The ratio of co-pollutant emissions to carbon-dioxide emissions varies depending on the fuel source (higher for coal, lower for natural gas, in-between for oil) and on pollution control technologies. In addition, damages per unit of co-pollutant emissions vary depending, among other things, on stack heights, population densities, and total exposure (the marginal damage function is usually assumed to be convex, with marginal damage increasing in total exposure).

These variations are illustrated in Figure 1, which shows co-pollutant intensity for air toxics releases reported in the USEPA's Toxics Release Inventory (TRI) from three industrial sectors: petroleum refineries, cement manufacturing, and power plants. Panel (a) shows total mass of releases (kilograms) of the roughly 600 chemicals in the TRI database per ton of carbon-dioxide emissions. By this measure, petroleum refineries have roughly twice the co-pollutant intensity of cement manufacturing facilities, with power plants lying between the two. Panel (b) shows the relative human health impacts of these same releases, taking into account stack heights, toxicities, the fate-and-transport of chemicals in the environment, and population densities. Petroleum refineries again score highest by this measure, but power plants score below cement manufacturing.

Figure 1: Intersectoral variations in co-pollutant intensity
(air toxics/ton CO₂)



From the standpoint of efficiency, the existence of co-pollutants therefore implies not only that the cap on carbon emissions should be tighter than what would be warranted by the environmental impacts of carbon-dioxide alone, but also that policy design should respond to variations in co-pollution intensity.

Environmental considerations

The environmental objective refers to the full range of pollution-reduction benefits that AB 32 implementation can bring about. Section 38501(h) of AB 32 explicitly sets forth this objective:

It is the intent of the Legislature that the State Air Resources Board design emissions reduction measures to meet the statewide emissions limits for greenhouse gases established pursuant to this division in a manner that minimizes costs and maximizes benefits for California's economy, improves and modernizes California's energy infrastructure and maintains electric system reliability, maximizes additional environmental and economic co-benefits for California, and complements the state's efforts to improve air quality.

Among possible uses of revenue generated under AB 32, CARB's December 2008 Scoping Plan includes:

***Achieving environmental co-benefits** – Criteria and toxic air pollutants create health risks, and some communities bear a disproportionate burden from air pollution. Revenues could be used to enhance greenhouse gas emission reductions that also provide reductions in air and other pollutants that affect public health.⁶*

Air pollution is generated by a variety of sources, not all of them related to fossil fuels. Examples of other sources include solvent evaporation, waste disposal, and (in the case of particulate matter) windblown dust. The production and use of fossil fuels account for a substantial share of emissions of many important pollutants.

Table 1: Percentage share of California emissions derived from production and use of fossil fuels

<i>Pollutants:</i>	ROG	CO	NOX	SOX	PM2.5
<i>Sources:</i>					
Fuel combustion (stationary & residential)	3.8	7.2	10.4	2.9	20.8
Mobile sources	51.2	79.8	85.5	58.9	19.7
Petroleum production & marketing	6.1	0.1	0.3	14.1	0.5
Total	61.1	87.1	96.2	73.0	41.0

Key: ROG = reactive organic gases SOX = sulfur oxides
CO = carbon monoxide PM2.5 = fine particulate matter
NOX = nitrogen oxides

Source: CARB, "Almanac Emission Projection Data (Published in 2009)," online at http://www.arb.ca.gov/app/emsinv/emssumcat_query.php?F_YR=2008&F_DIV=-4&F_SEASON=A&SP=2009&F_AREA=CA

⁶ CARB, *Climate Change Scoping Plan: A Framework for Change*. Pursuant to AB 32, The California Global Warming Solutions Act of 2006, December 2008, p. 70.

Table 1 presents data on fossil-fuel related emissions of reactive organic gases and four criteria air pollutants as a share of total statewide emissions. The contribution of fossil fuels ranges from 41% in the case of fine particulate matter to 96% in the case of nitrogen oxides. The transportation sector (mobile sources) accounts for the major share with the exception of fine particulate matter, where stationary and residential sources contribute slightly more to the total.

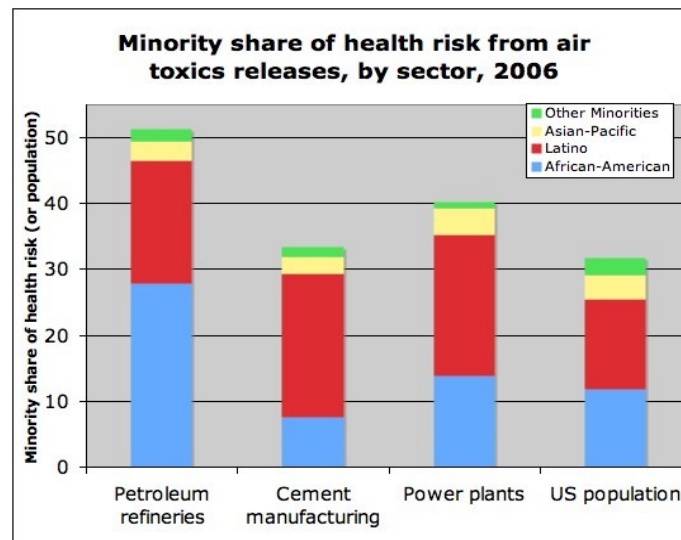
If, as is commonly assumed, air pollution damages are convex in total exposure – that is, marginal damage per ton of pollution exceeds average damage per ton – then the environmental significance of reductions in co-pollutants as a co-benefit of carbon policy may be even larger than the numbers in the table suggest.

Fairness considerations

The fairness objective implies that policy should seek to reduce disproportionate pollution in historically overburdened communities. For this reason the issue of co-pollutants has been emphasized by the Environmental Justice Advisory Committee (EJAC).

If co-pollutants were uniformly (or randomly) distributed across the landscape, there would be no fairness reason to design policy to take them into account. But again, both *a priori* reasoning and empirical evidence tell us that they are not uniformly distributed, and that some communities – often lower-income communities – are overburdened by co-pollutants. Figure 2 illustrates this point, showing health risks from air toxics for the same three industrial sectors, relative to the shares of demographic subgroups in the national population. Petroleum refineries have the most disproportionate impact.

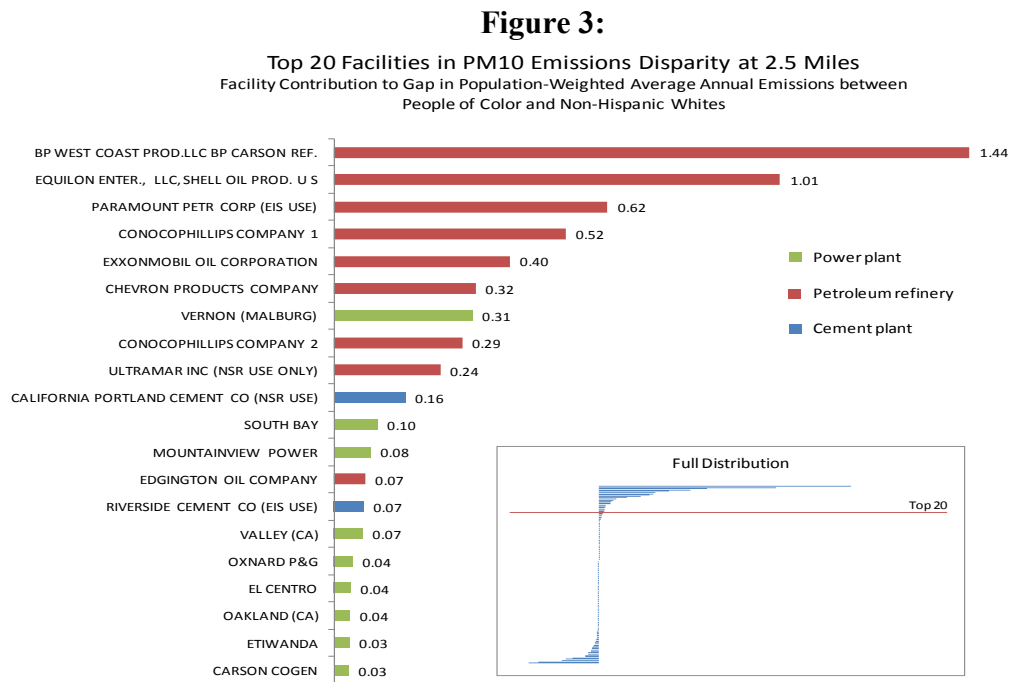
Figure 2: Shares of health risk from air toxics



Source: Minority shares of health impact calculated from RSEI-GM data; for methodology, see Ash et al., *Justice in the Air: Tracking Toxic Pollution from America's Industries and Companies to our States, Cities and Neighborhoods*, PERI and PERE, April 2009.

In an analysis of a different co-pollutant – particulate matter – a new study from the University of Southern California’s Program for Environmental and Regional Equity similarly concludes that petroleum refineries have greater disproportionate impact than power plants or cement plants.⁷

Disaggregating among facilities, the USC study finds that a relatively small number of refineries contribute a “hugely disproportionate share” to these disparate impacts. This is depicted in Figure 3, which shows the contribution of individual facilities to the gap in population-weighted emissions between people of color and non-Hispanic whites living within 2.5 miles of the facility.



Source: Pastor et al. (2010), Figure 9.

CARB recently resolved “to develop a methodology using available information to assess the potential cumulative air pollution impacts of proposed regulations to implement the Scoping Plan” and “to identify communities already adversely impacted by air pollution as specified in Health and Safety Code section 38750(b)(1) before the adoption of a cap-and-trade program.”⁸ The resulting information is expected to influence policy design.

⁷ Manuel Pastor, Rachel Morello-Frosch, James Sadd and Justin Scoggins, “Risky Business: Carbon Markets, Public Health, and Social Equity,” Los Angeles: USC Program on Environmental and Regional Equity, forthcoming in early 2010.

⁸ CARB, “Climate Change Scoping Plan, Resolution 08-47,” December 11, 2009, p. 8. See also Manuel Pastor, Rachel Morello-Frosch and Jim Sadd, “Environmental Justice Screening Method: Integrating Indicators of Cumulative Impact and Community Vulnerability into Regulatory Decision-making,”

Researchers at the University of Southern California, Occidental College, and the University of California, Berkeley, have initiated work to assist CARB in these tasks, developing a Cumulative Impact score method to screen for disproportionate air pollution impacts based on (i) hazard proximity and sensitive land uses, (ii) health risk, and (iii) social and health vulnerability.⁹ Applying this methodology, the researchers have identified the highest-scoring census tracts in the six-county SCAG (Southern California Association of Governments) area. Socio-demographic data show that these tracts have relatively high percentages of Latinos and African-Americans and relatively low incomes (see Table 2).

Table 2: Socio-Demographic Characteristics (2000) for Tracts with Highest Cumulative Impact Score, 6-County SCAG Area

	Top 6.2% of tracts	Top 12.9% of tracts	Top 20.1% of tracts	SCAG area totals
Total population	924,584	2,035,173	3,270,659	16,479,143
% population	5.6%	12.3%	19.8%	100.0%
% nonwhite	95.4%	92.8%	89.9%	61.2%
% below poverty	33.2%	30.2%	27.9%	15.7%
Median household income	\$25,269	\$27,533	\$29,686	\$50,165
Per capita income	\$9,221	\$10,097	\$10,880	\$21,101
% black	7.7%	9.2%	10.4%	7.3%
% Hispanic	79.0%	74.5%	69.9%	40.6%
% Asian	7.4%	7.7%	7.8%	10.4%
% other race	1.2%	1.5%	1.8%	2.8%

Source: Unpublished data furnished upon request by Dr. Manuel Pastor, University of Southern California, Program for Environmental & Regional Equity.

Policy Options

The remainder of this memorandum sketches four policies that could be implemented in order to advance the efficiency, environmental, and fairness objectives of AB 32 in relation to co-pollutants: (i) investment by allocating allowance value to a community

presented at CARB Informational Board Workshop on Policy Tools for the AB 32 Scoping Plan, May 28, 2008, online at http://www.arb.ca.gov/cc/scopingplan/meetings/5_28notice/presentations/pastor_5_28.pdf.

⁹ For details, see Manuel Pastor, Jim Sadd and Rachel Morello-Frosch, "Air Quality, Environmental Justice, and Social Vulnerability," presented at the South Coast Air Quality Management District Conference on New Perspectives on Community Health and Air Quality, July 24, 2009. Online at http://www.aqmd.gov/pubinfo/events/communityhealthairqualityconf/PDF/Pastor_AQMDJuly2009.pdf.

benefits fund; (ii) a co-pollutant surcharge; (iii) zonal trading systems; and (iv) priority facility designations.

(i) Investment: Community benefits fund

One way to tackle co-pollutant issues in AB 32 implementation is to allocate some fraction of the revenue from permit auctions to overburdened communities, with the money to be used for environmental improvements.

In its Final Report, the Economic and Technology Advancement Advisory Committee recommended this as one use of auction revenues (which it proposed be routed through a California Carbon Trust):

By setting aside a fixed portion of its funds to be distributed to projects based on cumulative impacts, geographic location, demographics, and/or associated co-benefits, this Trust could also help to reach important environmental justice goals. Distributing funds based on geography or demography would ensure that disadvantaged communities receive a pre-determined amount of funding from projects that not only reduce carbon emissions, but also foster community development and protect low income consumers from rising energy prices.¹⁰

Issues in developing and implementing a community benefits fund (CBF) policy include:

- how much revenue (or more precisely, the percentage of allowance value) to allocate to CBF;
- which communities are eligible to receive funds;
- what sorts of environmental projects are eligible; and
- what mechanisms should be established to allocate funds across and within communities.

California Assembly Bill 1405, currently being considered in the state legislature, contains specific proposals on these issues. The bill would require that a minimum of 30% of the revenues generated under AB 32 be deposited into the CBF. The bill defines “the most impacted and disadvantaged communities as those areas within each air basin with the highest 10 percent of air pollution impacts, taking into account air pollution exposures and socioeconomic indicators.” Within these communities, the CBF would provide competitive grants for projects for purposes such as reducing emissions of greenhouse gases and co-pollutants, minimizing health impacts caused by global

¹⁰ *Recommendations of the Economic and Technology Advancement Advisory Committee (ETAAC), Final Report.* February 11, 2008, p 2-5. Online at <http://www.arb.ca.gov/cc/etaac/ETAACFinalReport2-11-08.pdf>. Similarly, in a paper titled “Addressing Environmental Justice Concerns in the Design of California’s Climate Policy” (October 2009, p. 28), Schatzki and Stavins propose that allowance value “could be directed toward funding or creating incentives for measures designed to improve air quality or health services in particular communities of concern.” Online at http://www.climatechange.ca.gov/eaac/comments/2009-11-03_Schatzki_and_Stavins_attachment.pdf.

warming, and emergency preparedness for extreme weather events caused by global warming.¹¹

The language in AB 1405 provides a reasonable basis for EAAC and CARB to envision how a CBF component might work. In thinking through this prong of a strategy to incorporate co-benefits in policy design, the main issue for EAAC is the appropriate percentage of allowance value to be allocated to this use. For example, a “10-10” formula might allocate 10% of total allowance value to localities with the highest 10% of air pollution impacts.

(ii) Co-pollutant surcharge

A second way to incorporate co-pollutants into AB 32 implementation policy is to levy a surcharge on carbon permits in overburdened jurisdictions, and to dedicate the surcharge revenue to community benefits funds in the same jurisdictions where it is collected.

Attractive features of this option include the following:

- The use of surcharge revenue for this purpose would reduce the need to allocate revenues from carbon permit auctions to CBFs.
- There would be a tight nexus between the fee (surcharge) and its use.
- The surcharge would promote greater emission reductions in places where abatement benefits are greater due to high co-pollutant burdens.
- It affirms the principle that the “sink” functions of air (as a medium for disposal of wastes) belong to the people who breathe it.

To implement such a system, CARB would again identify overburdened locations where the co-pollutant surcharge would be levied, at the time of carbon permit surrender in the case of stationary sources or and the time of fuel delivery in the case of residential and mobile sources. By increasing the price of fossil fuels above what it would be in the absence of the surcharge, this would provide an incentive for greater emissions reductions in these locations. The revenue from the surcharge would then be allocated to CBFs in the same locations.

(iii) Zonal trading systems

A third way to include co-benefits from co-pollutant reductions in cap-and-trade policy design is to establish “zones” to guarantee some minimum level of emissions reductions in high-priority locations where co-benefits are greatest. Such areas may be identified using the methodology currently being developed by CARB.

¹¹ As of this writing, versions of AB 1405 have been passed by the Assembly and two Senate committees. The text is available at http://www.leginfo.ca.gov/pub/09-10/bill/asm/ab_1401-1450/ab_1405_bill_20090723_amended_sen_v94.pdf.

In zonal trading systems, the availability of permits is defined on a zone-by-zone basis, i.e., permits are allocated across zones within the overall cap. Zone-based “sub-caps” can be established regardless of whether permits are distributed via auction, free allowances, or some combination of the two. The zones create semi-permeable boundaries for permit trading: polluters in lower-priority zones can buy permits from polluters in higher-priority zones, but permit trades against this gradient are not allowed.

Similarly, the purchase of offsets is constrained or proscribed altogether in high-priority zones. In the presence of co-pollutants, the purchase of offsets from out-of-state has the effect of exporting the co-benefits from air quality improvements.¹² In the same way, offsets would result in the loss of co-benefits from co-pollutant reduction in high-priority zones.

A zonal system need not be restricted to point-source emissions: it could be applied to mobile sources, too, which as noted in Table 1 above account for a large share of emissions of some co-pollutants. Just as AB 32 effectively makes the state of California into a “zone” where carbon emissions from both point sources and mobile sources can be capped differentially from other states, so a zonal system can differentiate across regions and/or localities within the state.

One precedent for a zonal trading system is California’s Regional Clean Air Incentives Market (RECLAIM), launched in 1994 to reduce point-source emissions of nitrogen oxides and sulfur oxides in the Los Angeles basin. The South Coast Air Quality Management District established two zones under RECLAIM: zone 1, the coastal zone, where pollution is more severe and the benefits from pollution reduction are considered to be greater; and zone 2, the inland zone, where pollution is less severe. Facilities in zone 1 can buy permits only from other facilities in the same zone; facilities in zone 2 can buy permits from either zone. One impact of the RECLAIM zonal trading system is that average permit prices have been roughly eight times higher in zone 1 than in zone 2.¹³

In the absence of regionally variable co-pollutant intensity, these permit price differentials across zones would be a symptom of inefficiency. If marginal abatement benefits were equal across pollution sources, the efficiency criterion would call for equalization of marginal abatement costs as well. But as noted above, co-pollutants result in variations in marginal abatement benefits, and for this reason, permit price differentials can be an efficiency-improving result.

A zonal trading system – whether comprising two zones as in RECLAIM, or several zones – cannot, of course, perfectly match marginal abatement costs to all variations across pollution sources in marginal abatement benefits. Within any zone, some

¹² David Roland-Holst, “Carbon Emission Offsets and Criteria Pollutants: A California Assessment,” University of California Berkeley, Center for Energy, Resources, and Economic Sustainability, Research Paper No. 0903091, March 2009.

¹³ Lata Gangadharan, “Analysis of prices in tradable emission markets: An empirical study of the Regional Clean Air Incentives Market in Los Angeles,” *Applied Economics* 36: 1569-1582, 2004.

variations will persist. But the question is not whether a zonal trading system yields textbook efficiency; it is whether it yields a better outcome in terms of environmental, efficiency, and equity criteria than a system without zones. When externalities are spatially differentiated – that is, when emission location matters – zonal trading systems can be a “second-best” solution that yields a better outcome than the no-zone alternative.¹⁴

(iv) Priority facility or sector designations

A fourth option is to identify specific facilities or sectors that emit high levels of co-pollutants and/or make the most significant contributions to co-pollutant burdens in disadvantaged communities, and to designate these as priority facilities or sectors for carbon emission reductions.¹⁵ Again, such facilities or sectors may be identified using methodology currently being developed by CARB.

Similar to zonal trading systems, within the overall cap the priority designation would establish “sub-caps” on the number of permits available to individual facilities or facilities in a specific sector. Again, the policy would create a semi-permeable boundary: other polluters can buy permits from designated priority facilities, but not vice versa. Similarly, the purchase of offsets by priority facilities would be constrained or proscribed.

This policy option takes advantage of the common phenomenon of “disproportionality” in environmental impacts: a few facilities with much higher than average impacts often account for a large fraction of the total impact.¹⁶ By targeting a relatively small number of facilities that account for a relatively large share of co-pollutant damages in disadvantaged communities, this policy could achieve a large payoff while economizing on administrative burdens.

Concluding remarks

Policies to reduce carbon-dioxide emissions from burning fossil fuels generate co-benefits – above and beyond the climate-change benefits – by reducing emissions of co-pollutants that harm human health. Valuation studies suggest that these co-benefits are comparable in magnitude to the benefits of carbon-dioxide emission reductions alone.

¹⁴ Tom Tietenberg, “Tradeable permits for pollution control when emission location matters: What have we learned?” *Environmental and Resource Economics* 5: 95-113, 1995.

¹⁵ The significance of plant-to-plant variations in co-pollutant intensity is underscored in the National Academy of Sciences study. See the comments of Professor Maureen Cropper, vice-chair of the NAS committee that produced the study, in *The New York Times*, October 20, 2009: <http://www.nytimes.com/2009/10/20/science/earth/20fossil.html>. For illustrations from California, see the USC study (cited in note #6 above).

¹⁶ See Figure 3 above. For discussion, see also Lisa M. Berry, “Inequality in the Creation of Environmental Harm: Looking for Answers from Within,” in Robert C. Wilkinson and William R. Freudenberg, eds., *Equity and the Environment: Research in Social Problems and Public Policy, Volume 15*. Amsterdam: Elsevier, 2008.

Damages from co-pollutants per unit carbon-dioxide emissions vary across locations and pollution sources. Historically overburdened communities tend to be economically and socially disadvantaged in other respects as well.

Hence the efficiency, environmental, and fairness objectives of AB 32 can be furthered by policies that take co-pollutants and co-benefits into account.

This memorandum has sketched four policy options:

- (i) allocating some fraction of allowance value to community benefits funds (CBFs);
- (ii) introducing a co-pollutant surcharge, with the proceeds dedicated to CBFs;
- (iii) establishing a zonal trading system that restricts the ability of polluters in high-priority localities from “buying out” of emission-reduction obligations by purchasing offsets or permits from other localities; and
- (iv) designate priority facilities or sectors for co-pollutant reductions, with restrictions on their ability to purchase offsets or permits from other polluters.

These four options are not mutually exclusive. Rather they can be regarded as complementary instruments to advance the same goal: incorporating co-pollutants and the co-benefits from their reduction into climate policy design.